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WITNESS my hand this
Eighteenth day of October 2004

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Regulation 3.2

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Invention Title: "A SURVEILLANCE SYSTEM"

The invention is described in the following statement:

TITLE

System and Method for Image Monitoring

FIELD OF THE INVENTION

The invention relates to obtaining and monitoring digital images. In particular, although not exclusively, the invention relates to an improved security system and method for obtaining automatic, sequential digital still images using power efficient cameras and for processing the images to determine whether an anomalous event has occurred.

BACKGROUND TO THE INVENTION

Video image monitoring systems such as security systems are increasingly common as the costs of cameras and image processing and communications technologies decrease. Often such systems include several cameras connected to a bank of video monitors overseen by a security guard. These systems suffer from limitations however as the number of cameras increases. First, wiring both power and data cables to each of the cameras significantly increases costs and complexity. Second, the amount of data received and recorded by a system frequently becomes unmanageable. Third, the ability to monitor simultaneously all of the cameras decreases, resulting in a higher probability that an anomalous event such as a security breach will go unnoticed.

There is therefore a need for an improved image monitoring system and method that overcomes the above limitations.

OBJECTS OF THE INVENTION

Therefore an object of the present invention is to overcome or at least alleviate one or more of the above limitations including providing an image monitoring system comprising power efficient cameras.

Another object of the present invention is to provide an image monitoring system and method that activates cameras based on motion detection.

Another object of the present invention is to provide an image monitoring system that minimizes false alarms.

Still another object of the present invention is to provide an image monitoring system having improved low-light imaging capability.

Yet another object of the present invention is to provide an image monitoring system and method that requires less memory.

SUMMARY OF THE INVENTION

Accordingly, in one form, although it need not be the only or indeed the broadest form, the invention resides in an image monitoring system comprising a central controller operatively connected using wired or wireless links to a plurality of digital still camera units. The central controller is operatively connected using a wired or wireless link to a monitoring station, which in turn may be connected to authorities such as the police. The camera units include a means for detecting motion and may download a series of images to the central controller when motion is detected. The camera units also may include limited processing capabilities so that images may be analyzed at the camera units to determine whether images and/or data should be relayed to the central controller. Software in the central controller then interprets images and data received from the camera units and determines whether the images or analysis data should be forwarded to the monitoring station. The monitoring station then performs a final analysis on the images and/or data received from the central controller and determines whether an alarm should be sent to an authority.

In another form, the invention resides in a method for image monitoring comprising the steps of detecting motion at a camera unit; transmitting a series of still images to a central controller when motion is detected; analyzing the images in the central controller to determine whether an anomalous event has occurred; transmitting the images and/or data related to the images to a monitoring station; and analyzing at the monitoring station the images and/or data received from the central controller to determine whether an alarm should be sent to an authority.

The camera units may include a pre-trigger feature that, following a triggering event, transmits to the central controller a series of buffered images captured before the triggering event.

The camera units may also include a microphone for detecting sound.

The monitoring station may be manned or unmanned.

The power consumption of a camera unit may be reduced by using direct memory access between an image sensor and a memory.

The camera unit may include a micro controller that compresses images before transmitting the images to the central controller.

The central controller may include a mesh networking protocol such that data may be routed indirectly through one or more camera units to and from the central controller.

The system may include a full duplex remote control for arming and disarming the system and for receiving images from individual camera units.

The camera units may include both a black and white and a colour image sensor to improve low-light sensitivity.

Further features of the present invention will become apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

To assist in understanding the invention and to enable a person skilled in the art to put the invention into practical effect preferred embodiments of the invention will be described by way of example only with reference to the accompanying drawings, wherein like reference numbers refer to like elements throughout the various views, in which:

FIG. 1 is a schematic block diagram of an image monitoring system according to an embodiment of the present invention;

FIG. 2 a schematic block diagram of a wireless camera unit according to an embodiment of the present invention;

FIG. 3 is a schematic block diagram of a central controller according to an embodiment of the present invention;

FIG. 4 is a schematic block diagram of components of a camera unit illustrating the use of DMA inputs according to an embodiment of the present invention;

FIG. 5 is a schematic block diagram of a central controller and four camera units wherein bad wireless reception exists between one of the camera

units and the central controller according to an embodiment of the present invention;

FIG. 6 is a flow diagram illustrating a method of operating a mesh network according to an embodiment of the present invention;

FIG. 7 is a timing diagram illustrating a pre-trigger feature according to an embodiment of the present invention;

FIG. 8 is a flow diagram illustrating a method for maintaining a pre-trigger buffer and for writing images to a memory card following a triggering event according to an embodiment of the present invention;

FIG. 9 is a schematic block diagram illustrating a bi-directional (full duplex) remote control for arming and disarming the system according to an embodiment of the present invention; and

FIG. 10 is a schematic block diagram illustrating a camera unit incorporating both a black and white image sensor and a colour image sensor according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, there is illustrated a schematic block diagram of an image monitoring system 100 according to an embodiment of the present invention. The system 100 includes a central controller 105 in wireless communication with a plurality of camera units 110. The central controller 105 is connected to a monitoring station 115 through a wired or wireless network 120. The monitoring station 115 in turn may be linked to authorities 125 such as the police.

The system 100 thus enables images from the camera units 110 to be wirelessly communicated to the central controller 105 where they are analyzed and, if warranted, some or all of the images or data related to the images are transferred to the monitoring station 115. The monitoring station 115, which may be manned or unmanned, then provides further analysis of the images and/or data and determines whether an alarm should be sent to the authorities 125.

Referring to FIG. 2, there is illustrated a schematic block diagram of a wireless camera unit 110. The camera unit 110 comprises a camera micro controller 205 connected to a power supply 210. Ideally, the power supply 210 is

a battery such that there is no need for connecting power supply wires to the camera unit 110; however, if a mains power outlet is conveniently located near a camera unit 110 it could also be used as a power supply 210. A removable memory card 240 and an image sensor 215 are also connected to the camera micro controller 205. A motion detector 220 such as a pyro electric infrared-detector may also be connected to the camera micro controller 205. Further, an I/O port of the micro controller is connected to an RF transceiver 225 including an antenna 230 for communicating with the central controller 105 and/or with other camera units 110 or a remote control as discussed further below. If a wired network is located near the camera unit 110, the camera micro controller 205 could also be connected to a wired network 235. The camera micro controllers 205 may also function to compress images before images are transmitted to the central controller 105.

Referring to FIG. 3, there is illustrated a schematic block diagram of the central controller 105. The central controller 105 includes a central micro controller 305 connected to a hard drive 315 and to a removable memory card 340. The central micro controller 305 is also connected to an RF transceiver 325 for receiving wireless signals from the RF transceivers 225 of the camera units 110. The central micro controller 305 is also connected to wired link 305 or wireless link 310 for communicating with the monitoring station 115.

The present invention is therefore able to minimize the number of false alarms that are reported to the authorities 125 by using a series of filtering events. First, a camera unit 110 will generally not report images to the central controller 105 unless the camera unit 110 has first detected motion. Motion may be detected by a camera unit 110 either by a motion detector 220 or through analysis of a series of still images conducted by the camera micro controller 205. In the latter case, using image analysis software that is well known in the art, by detecting whether features between successive images from a given camera unit 110 change, the camera micro controller 205 can determine whether motion has been detected by its associated image sensor 215.

Second, software associated with the central controller 105 may perform a preliminary analysis of the motion that has been recorded by a camera unit 110. For example, the central controller 105 may be programmed to ignore

certain types of motion that are anticipated by the system 100 and that should not result in the issuance of an alarm. Such anticipated motions may include for example the operation of machinery or the regularly scheduled patrols of a security guard. Thus the central controller 105 may be programmed to analyze sequential motion detections captured by several camera units 110. For example, a security guard on patrol may be expected to trigger first, second and third cameras sequentially during a predefined time period. The system 100 could be programmed to ignore such anticipated triggering events. For example, such anticipated events could be filtered at the individual cameras which could be programmed not to report such events to the central controller 105; or the central controller 105 could be programmed to filter such events and not report them to the monitoring station 115. However, if the above described anticipated sequence of the triggered camera units 110 changed, or for example if the timing of such a sequence changed, the central controller 105 could be programmed to report an anomalous event to the monitoring station 115.

Third, the monitoring station 115 may apply a final filter of the recorded motion before issuing an alarm to the authorities 125. For example, a security guard may monitor the monitoring station 115. The security guard could therefore make a judgment concerning whether an anomalous event reported by the central controller 105 warranted issuing an alarm to the authorities 125. Alternatively, the monitoring station 115 could be unmanned; in which case the monitoring station 115 could include additional processing algorithms for interpreting an anomalous event reported by the central controller 105. Depending on the output of the processing algorithm, the monitoring station 115 could issue an automated alert to the authorities 125.

The above-described multi-tiered filtering process concerning anomalous events also functions to reduce costs associated with the system 100. Costs are reduced because the most expensive analysis processes and hardware may be highly centralized; whereas the less expensive analysis processes and hardware may be widely distributed. For example, expensive analysis processes that require a human analyst such as a security guard or expensive processing equipment may be centralized in a single monitoring station 115. The single monitoring station 115 could be used to monitor dozens or even thousands of

homes or businesses. Each home or business could then include one central controller 105 that would monitor inputs from numerous camera units 110. The analysis capabilities of the central controllers 105, although not as sophisticated as the capabilities of the monitoring station 115, would in turn be more sophisticated than the individual camera units 110.

Further the link between the central controller 105 and the monitoring station 115 may include access to the Internet or other wireless networks such that users of the system may take advantage of existing communications infrastructures. Thus users of the system 100 could monitor outputs of either the central controller 105 or the monitoring station 115 through internet-enabled personal computers or through wireless devices such as mobile phones or personal digital assistants (PDAs).

Therefore each home or business connected to the system 100 is able to take advantage of a sophisticated filtering process that minimizes false alarms reported to authorities 125 and that also shares with other homes and businesses the costs of analyzing anomalous events. Thus the cost of the system to each individual home or business is significantly reduced.

The costs of the system 100 may also be decreased, and the convenience of the system 100 increased, by reducing the power consumption of the individual camera units 110. By making the camera units 110 wireless and by powering them with long-life batteries, the camera units 110 may be easily installed in remote areas such as around outdoor fence perimeters.

According to the present invention, the power consumption of a camera unit 110 may be dramatically reduced by first recording still images rather than video. A still image camera uses much less power than a video camera. However, the present invention is able to achieve most of the security benefits of live video by timing the still images reasonably close together and by using image analysis software to detect changes between sequentially recorded still images. As mentioned above, such image analysis software may be used to detect simple motion, or may be used to detect pre-defined anomalous events such as the presence of a person in a particular portion of an image such as near a fence line.

The rate at which images are captured by a given camera unit 110 may

depend on the location of the camera and the nature of anomalous events that the camera is intended to detect. For example, a camera unit 110 with a far field of view could be set a low image capture frequency because it would require a relatively long time for an object to pass across the camera unit's field of view. On the other hand a camera unit 110 with a near field of view, or a camera unit that is intended to detect fast moving objects, would be set at a higher image capture frequency.

Power consumption of a camera unit 110 may also be reduced through the use of direct memory access (DMA) inputs in the camera micro controllers 205. Referring to FIG. 4, there is a schematic block diagram of components of a camera unit 110 illustrating the use of such DMA inputs. In most standard digital still cameras, image data must pass from an image sensor through a control bus to an image processing ASIC. Only the image processing ASIC is able to then write the image data into memory. Such image processing ASICs are a hard-wired and power intensive means of transferring image data from an image sensor to memory. However, in the present invention that uses DMA, rather than forcing all I/O to and from the memory 240 to pass through an image processing ASIC, the image sensor 215 is able to write image data directly to the memory 240. DMA thus eliminates the need for an image processing ASIC and therefore reduces the power consumption and costs of the camera unit 110.

Other features of an embodiment of the present invention are now described below including the use of a mesh networking protocol, pre-trigger buffering, full duplex remote control, and improved low-light imaging.

Referring to FIG. 5, there is illustrated a schematic block diagram of a central controller 105 and four camera units 110 wherein bad wireless reception exists between one of the camera units 110 and the central controller 105. The present invention may employ a mesh networking protocol whereby image and/or control data can be sent either directly between a camera unit 110 and a central controller 105, or such data may be routed indirectly through one or more camera units 110 to and from the central controller 105. According to networking techniques well known in the art, and thus not required to be repeated in detail here, a mesh networking protocol of the present invention may be programmed to switch automatically between various alternative paths depending on

reception quality. Camera units 110 may also be programmed to relay data from remote camera units 110 to extend the active range of the system 100, without having to increase the power of the RF transceivers 225.

Referring to FIG. 6, there is a flow diagram illustrating a method 600 of operating a mesh network according to the present invention. The method 600 begins at step 605 that checks a route cache to determine whether a route exists between two points in the network. At step 610, if a route is known, the method 600 proceeds to step 615 where data is sent to its destination. However, if at step 610 a route between the two points does not exist in the route cache, the method 600 proceeds to step 620 where a route discovery algorithm is executed. After a route is discovered, the method 600 proceeds to step 615 where data is sent to its destination.

Referring to FIG. 7, there is a timing diagram illustrating a pre-trigger feature of the present invention. According to the pre-trigger feature, the camera units 110 store intermittent images in a RAM buffer such that when an anomalous event is detected by a motion detector 220, the related camera micro controller 205 transmits a present image from the image sensor 215 to the central controller 105 and also transmits a select number of previously buffered images to the central controller 105. In this manner, the method of the present invention is able to capture a series of events preceding a triggering event, enabling a more comprehensive temporal analysis of a situation.

Referring to FIG. 8, there is a flow diagram illustrating a method 800 for maintaining a pre-trigger buffer and for writing images to a memory card following a triggering event. The method 800 begins at step 805 where a pre-trigger image is recorded. At step 810 it is determined whether a pre-set number of *n* images have been captured in the pre-trigger buffer of an internal memory 240, where *n* is determined by the size of the buffer and the resolution of the buffered images. If *n* images have not been captured in the buffer, the present image is added to the buffer at step 815; however if *n* images have been captured in the buffer then the method 800 proceeds to step 820 where the oldest image in the buffer is deleted before the present image is added to the buffer at step 815. Next, a delay step 825 is introduced to space the images by a preset time interval, as discussed above concerning image capture frequency,

before the method 800 returns to step 805 to capture the next image. If a triggering event occurs at step 830, all of the pre-trigger images in the buffer are copied from the internal memory 240 to the central controller 105. Finally, other post-trigger tasks are performed such as transmitting other data such as sound data to the central controller 105 and resetting the trigger.

Referring to FIG. 9, there is a schematic block diagram illustrating a bi-directional (full duplex) remote control 905 for arming and disarming the system 100. Using the mesh networking protocol described above, each camera unit 110 in the system 100 may act as a receiver for the full duplex remote control 905 whereby arm/disarm and other commands may be transferred via the network to the central controller 105. A link from the network to the remote control 905 may also be used to display the status of the alarm system on a graphical user interface of the remote control 905.

Still another feature of an embodiment the present invention concerns improving the low-light sensitivity of the camera units 110. Referring to FIG. 10, there is a schematic block diagram illustrating a camera unit 110 incorporating both a black and white image sensor 245 and a colour image sensor 215. Normally, in low light conditions, colour image sensors don't respond well and produce poor quality images. Black and white image sensors are generally more sensitive and produce better quality images in low-light conditions. Further, the quality of the black and white images can be enhanced through the use of an infrared (IR) light array 250 that provides supplementary IR illumination of a scene.

As the ambient light falls below a pre-determined threshold, the camera micro controller 205 switches from the colour image sensor 215 to the black and white image sensor 245 and simultaneously activates the IR light array 250. The camera unit 110 may further include a microphone for monitoring activity in a low-light environment. As illustrated in FIG. 10, the low-light sensitivity of the camera units 110 may thus be ideal for monitoring a dark room such as where a baby is sleeping. An output of the low-light camera unit 110 could then be routed to a portable video display such as a graphical user interface on the remote control 905.

The present invention is therefore a system and method for image

monitoring that may be used as an improved security system 100. The system 100 obtains automatic, sequential digital still images to determine whether an anomalous event, such as a security breach, has occurred. The system 100 may further include sophisticated filtering processes that both a) minimize false alarms reported to authorities 125 and b) reduce costs by centralizing more expensive analysis hardware and resources and distributing less expensive analysis hardware and resources.

Throughout this specification the aim has been to describe the invention without limiting the invention to any one embodiment or specific collection of features. Persons skilled in the relevant art may realize variations from the specific embodiments that will nonetheless fall within the scope of the invention. It will therefore be appreciated that various other changes and modifications may be made to the embodiment described without departing from the spirit and scope of the invention.

Dated this 9th day of October 2003

Moreton Bay Systems

By their Patent Attorneys

FISHER ADAMS KELLY

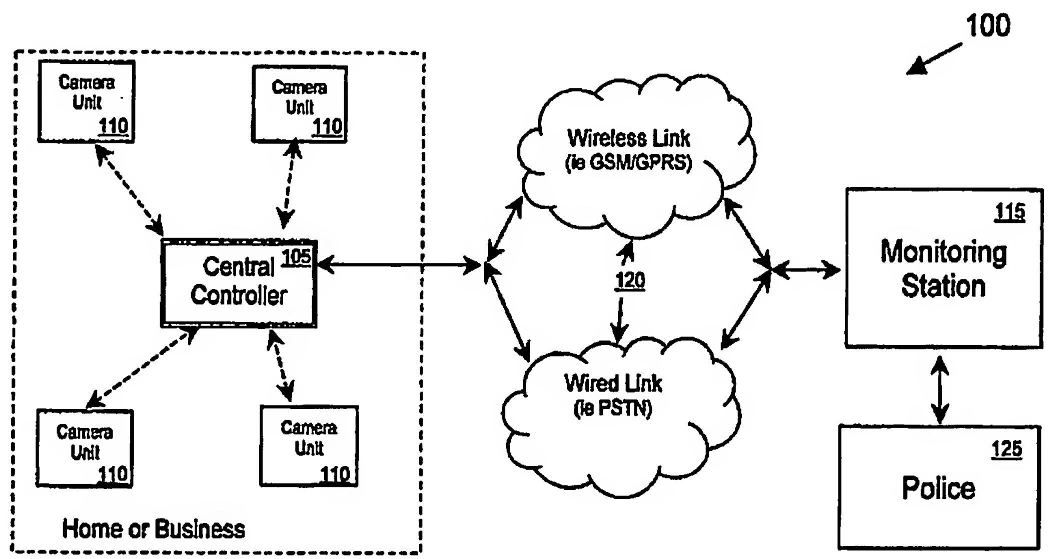
100
Camera Unit 110
Camera Unit 110
Central Controller 105
Camera Unit 110
Camera Unit 110
Home or Business
Wireless Link (ie GSM/GPRS)
120
Wired Link (ie PSTN)
115 Monitoring Station
125 Police

FIG 1

110

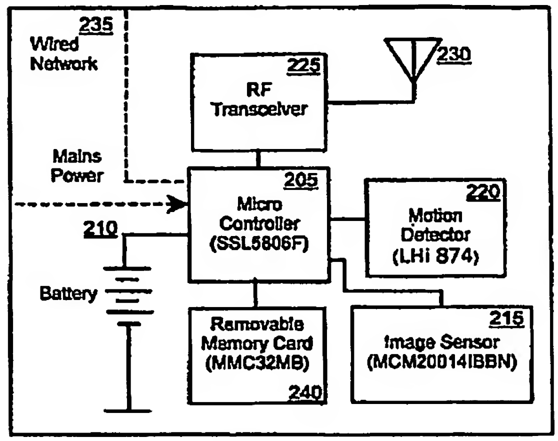

FIG 2

105

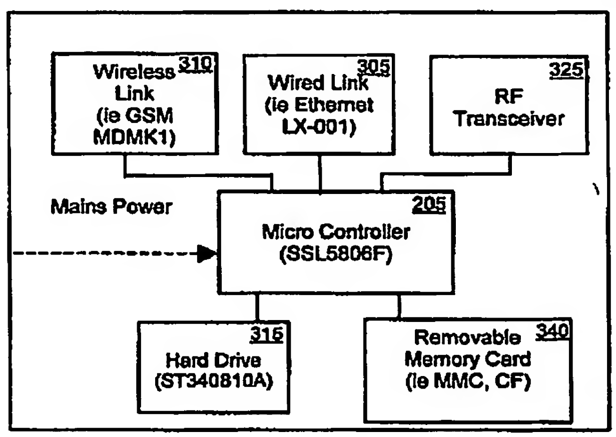

FIG 3

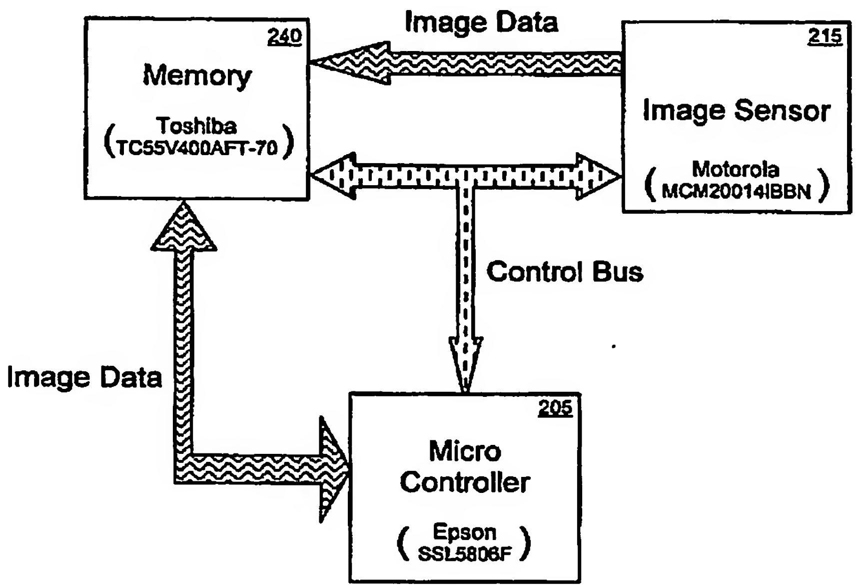
Image Data
Memory
240
Toshiba
(TC55V400AFT-70)
215
Image Sensor
Motorola
(MCM20014IBBN)
Control Bus
Image Data
205
Micro
Controller
(Epson
SSL5806F)

FIG 4

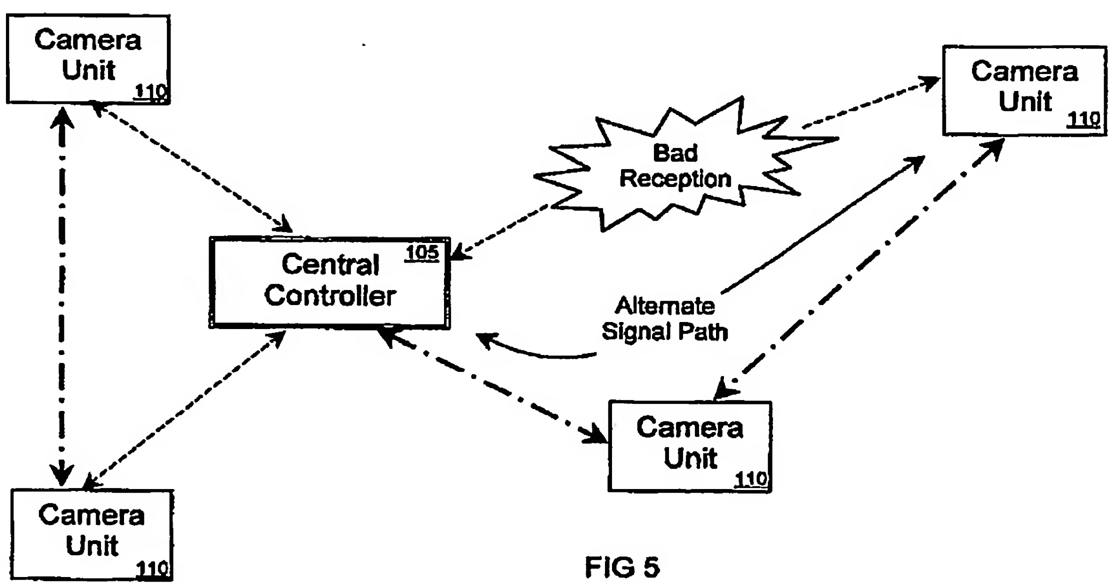
Camera
Unit
110
Bad
Reception
Camera
Unit
110
Central
Controller
105
Alternate
Signal Path
Camera
Unit
110
Camera
Unit
110

FIG 5

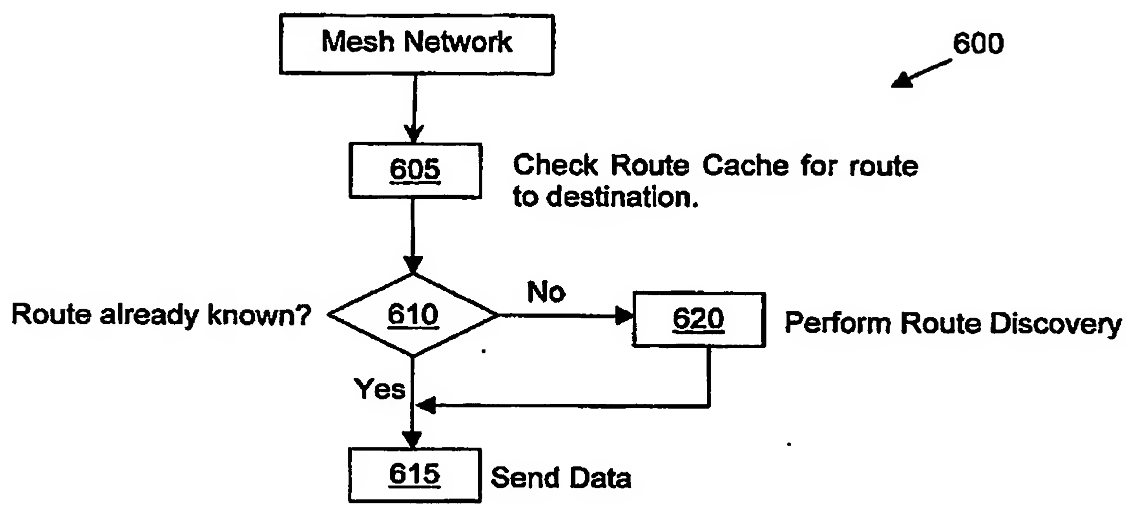
600
Mesh Network
605
Check Route Cache for route to destination.
Route already known?
610
No
620
Perform Route Discovery
Yes
615
Send Data

FIG 6

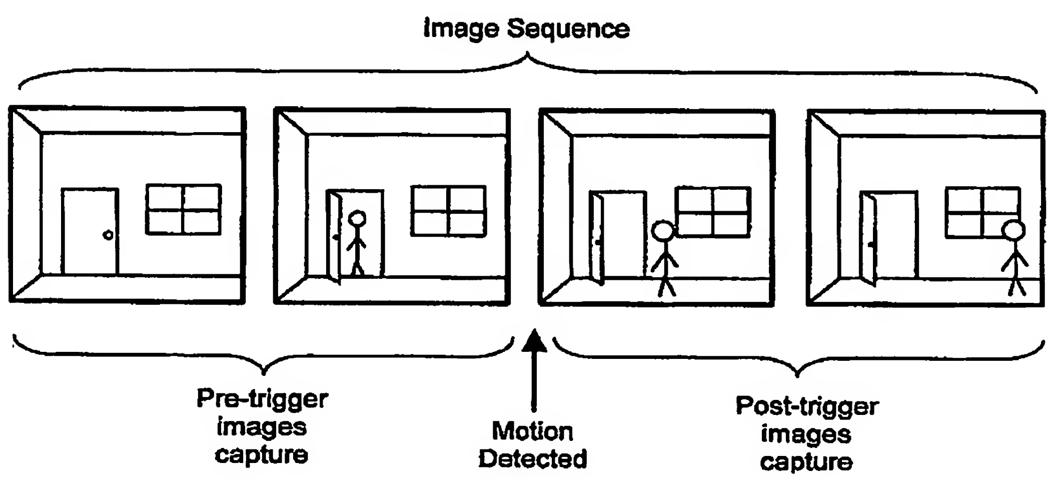
Image Sequence
Pre-trigger images capture
Motion Detected
Post-trigger images capture

FIG 7

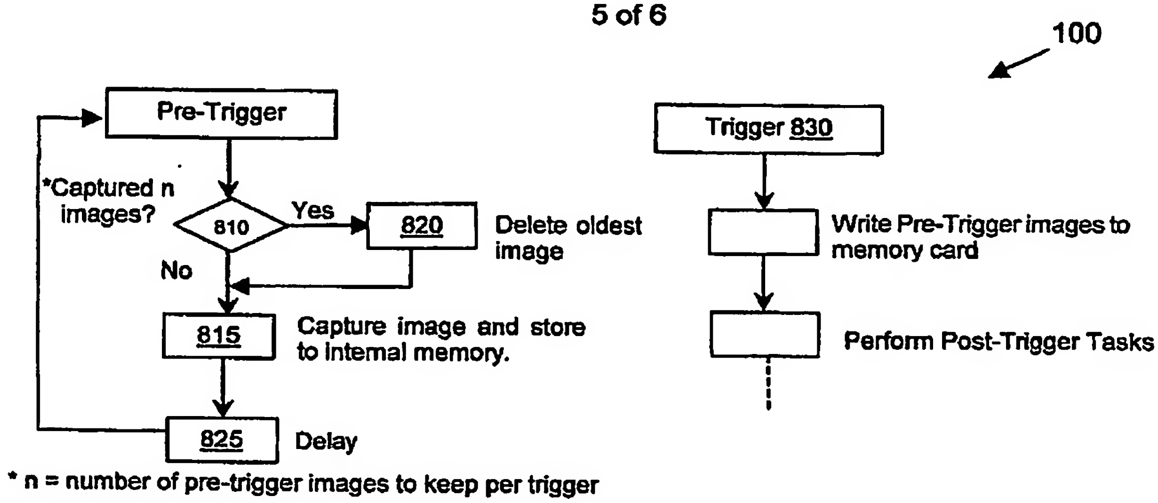
100
Pre-Trigger
*Captured n images?
810
Yes
820
Delete oldest image
No
815
Capture image and store to internal memory.
825
Delay
Trigger 830
Write Pre-Trigger images to memory card
Perform Post-Trigger Tasks
* n = number of pre-trigger images to keep per trigger

FIG 8

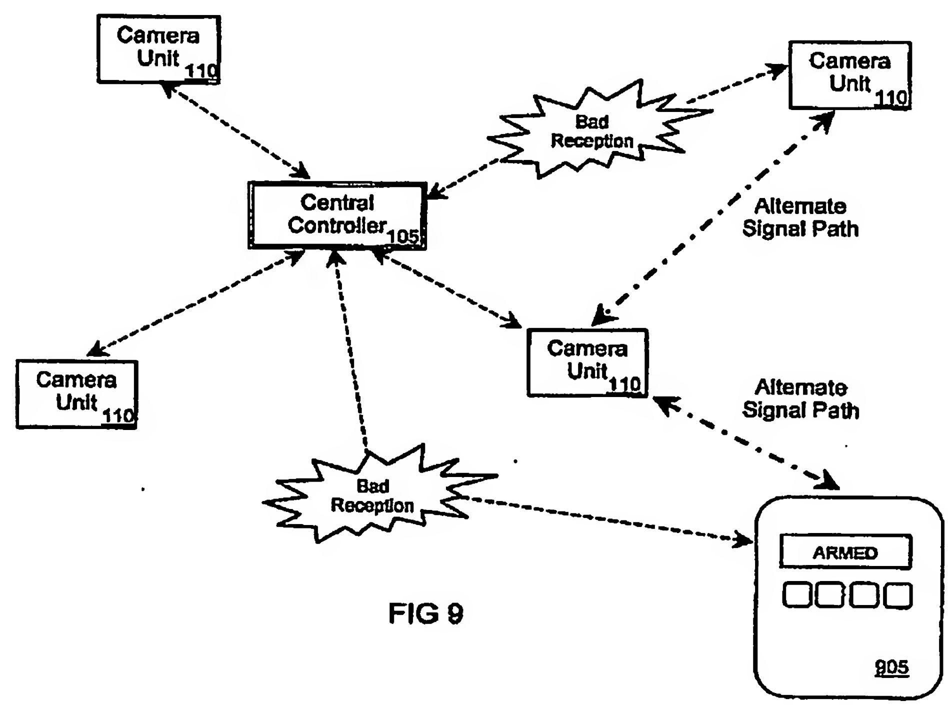
Camera Unit 110
Camera Unit 110
Bad Reception
Central Controller 105
Alternate Signal Path
Camera Unit 110
Camera Unit 110
Alternate Signal Path
Bad Reception
ARMED
905

FIG 9

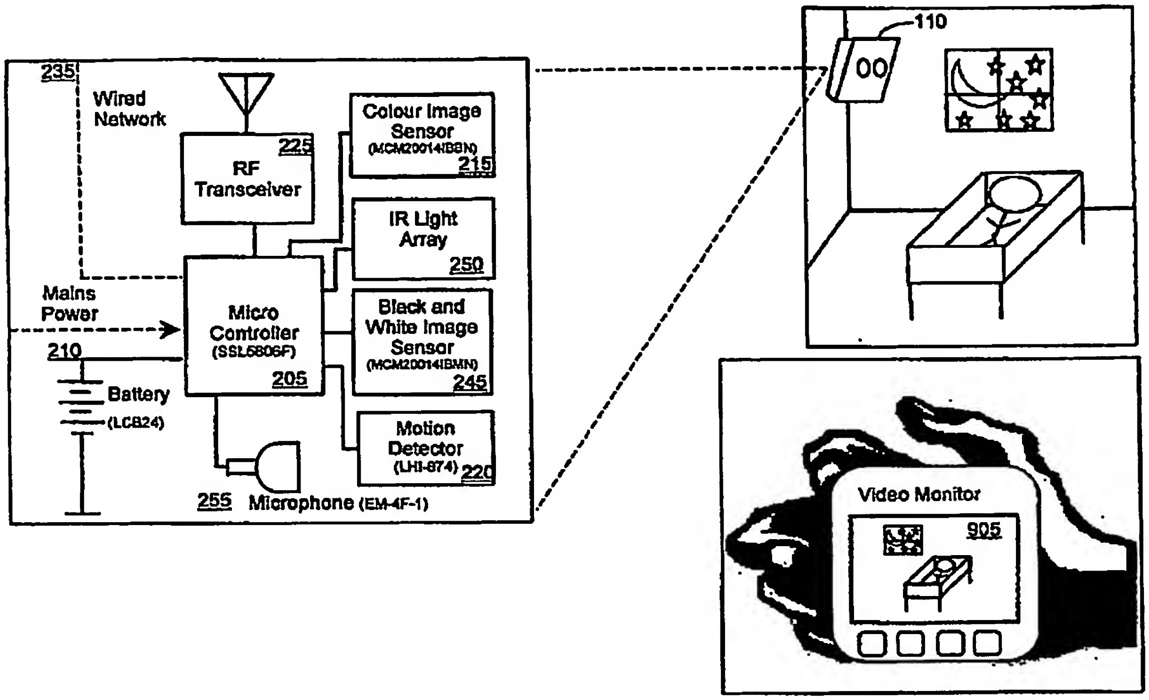
235
Wired Network
225
RF Transceiver
Colour Image Sensor
(MCM20014IBBN)
215
IR Light Array
250
Mains Power
Micro Controller
(SSL5806F)
205
210
Black and White Image Sensor
(MCM20014IBMN)
245
Battery
(LCB24)
Motion Detector
(LHI-874)
220
255
Microphone (EM-4F-1)
110
Video Monitor
905

FIG 10

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